



Advanced Light Armaments for Combat Vehicles (ALACV)

Advanced Kinetic Energy Activities and Demonstration Efforts

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Distribution Statement A: Unlimited.

Advanced KE Issues

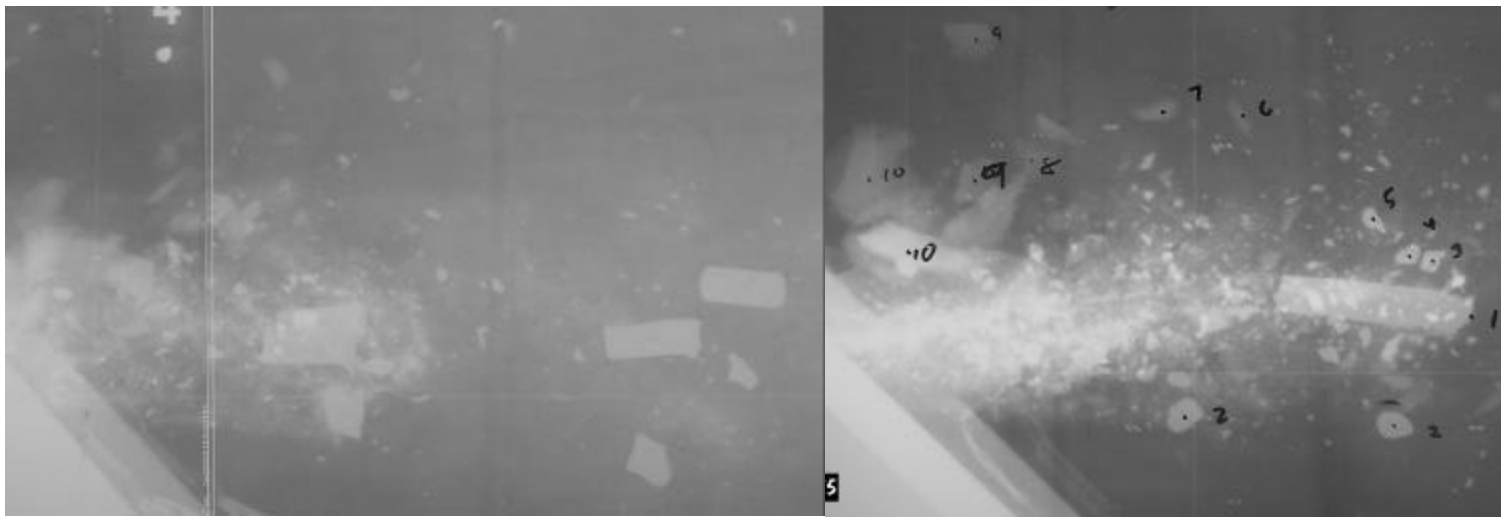
- Very little Behind Armor Debris (BAD) generated against aluminum armors (modern IFV targets)
- The residual penetrator and its own erosion products are the main source of lethal debris (low lethality of aluminum fragments)
- WHA penetrators often fracture against the more complex advanced armors, DU offers greater effectiveness by retaining its integrity.
 - Both W and DU have show minimal effectiveness against Al based targets.



BAD for Advanced Target (Aluminum Hull)



Weapons and Materials Research



WHA #2933

DU #2975

$V_s 1400$, $V_r 1053$

$V_s 1352$, $V_r 1034$

- Aluminum fragments visible in radiographs have little lethality₂
(low density and velocity)

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Advanced KE Objectives

- Develop and Demonstrate advanced KE penetrators that will achieve a 30% increase in Behind Armor Effects (BAE) over a 40mm, APFSDS round with a standard monolithic Tungsten (W) penetrator at a 1500m engagement range.
- Achieve these results using alternative W materials and revolutionary penetrator design concepts.
- Ensure the technologies are scalable to all calibers from 30mm to 50mm

Advanced KE Technical Team

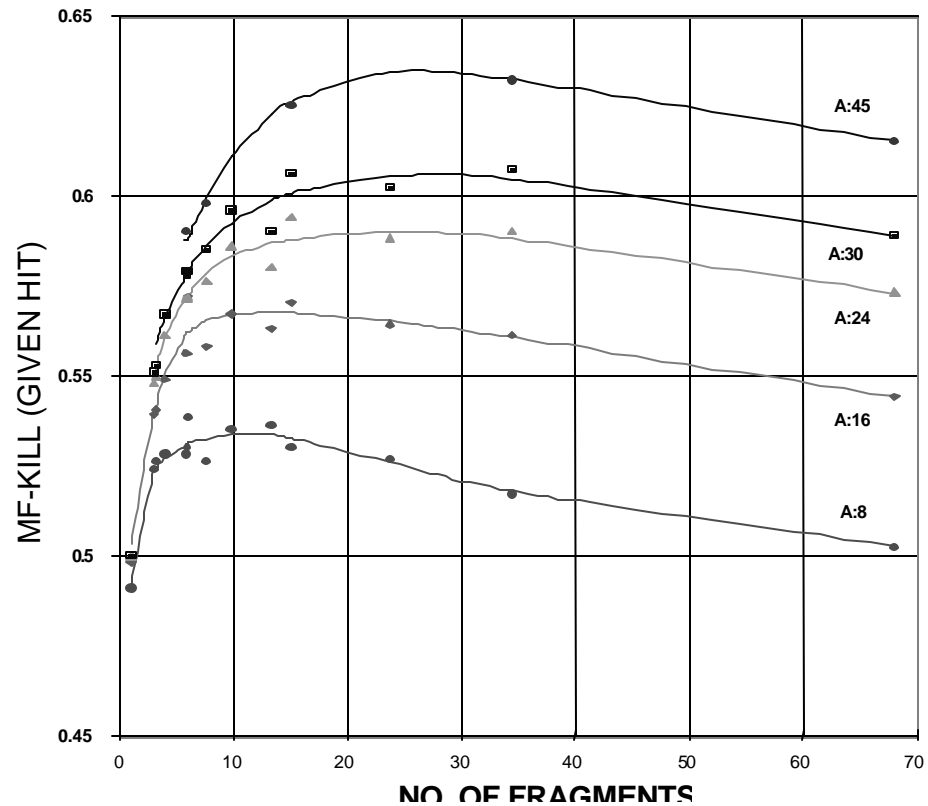
- Formed an Advanced KE Executive Steering Committee to address technical challenge
- Participants: CCAC (LAD & HAD), WECAC, ARL (WMRD & SLAD), GD-OTS (Marion), & AOT
- Three Committee Meetings held to date,
 - Nov 8th, Dec 6th, and Dec 19th
- First order of Business: Express the STO requirements in terms of measurable metrics in ballistic tests and lethality analyses

Quantifying the STO Requirement

- To increase BAE, one must optimize the BAD
 - Particle size & mass distribution, as well as Cone Angle, and Velocity of the Fragments
- BAE are not dependent of any one characteristic, but a culmination of all aspects
- Decided to tie BAE to an increase in measurable lethality (MF-KILL), given a hit.
 - 30% difference in performance between a basic and fully optimized (unachievable) penetrator

Lethality's dependency on Penetrator Fragments

The motivation for increasing the # of fragments generated by the residual penetrator and their angular distribution



A SLAD Parametric Study of an aluminum-hulled vehicle

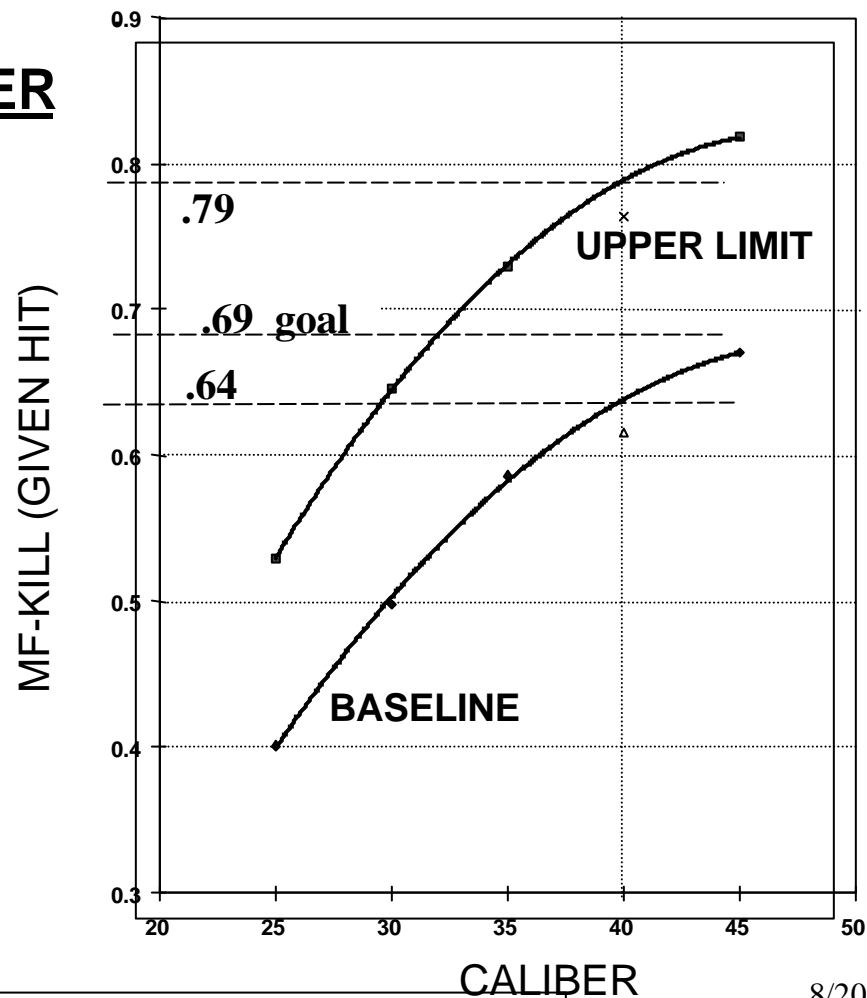
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Quantified BAE Increase

MF-KILL VS CALIBER

Goal: an approximate
10% increase in
Loss of Function for this
system



Technical Approach

- Goals:
 - Make the projectile more resistant to rod fracture
 - Increase Behind Armor Lethality
 - Make residual Rod contribute to BAD
- Possible Solutions:
 - Tougher Tungsten Materials (lower W content)
 - NOVEL Penetrator concepts
 - ENhanced Lateral Effects tubular cores (ENLE)
 - With Inert and Explosive materials

Complying w/ the STO Requirement

- Testing will be performed in ARL's Lab Facility
- Testing will be performed with un-finned cores, fired at short ranges against SNR targets w/BAD witness panels
- Spall data is to be analyzed by ARL (WMRD & SLAD), with results assessed in the Army's SQuASH model
- All testing in CY01 & CY02 will be performed against a single target aspect as a performance discriminator
- Target aspect to be chosen based on its estimated P_k being comparable to that of a full Cardioid average (full 360° engagement)

Concerns with Technical Approach

- Modifying the physical or mechanical properties of our baseline W core to get more BAEs could result in a trade-off in defeat range
 - Question: Is a small decrease in effective range acceptable?
- The magnitude of any demonstrated BAD will be SNR target dependent.
- The demonstrated levels of effectiveness (P_k) will be dependent on the size of the penetrator core.

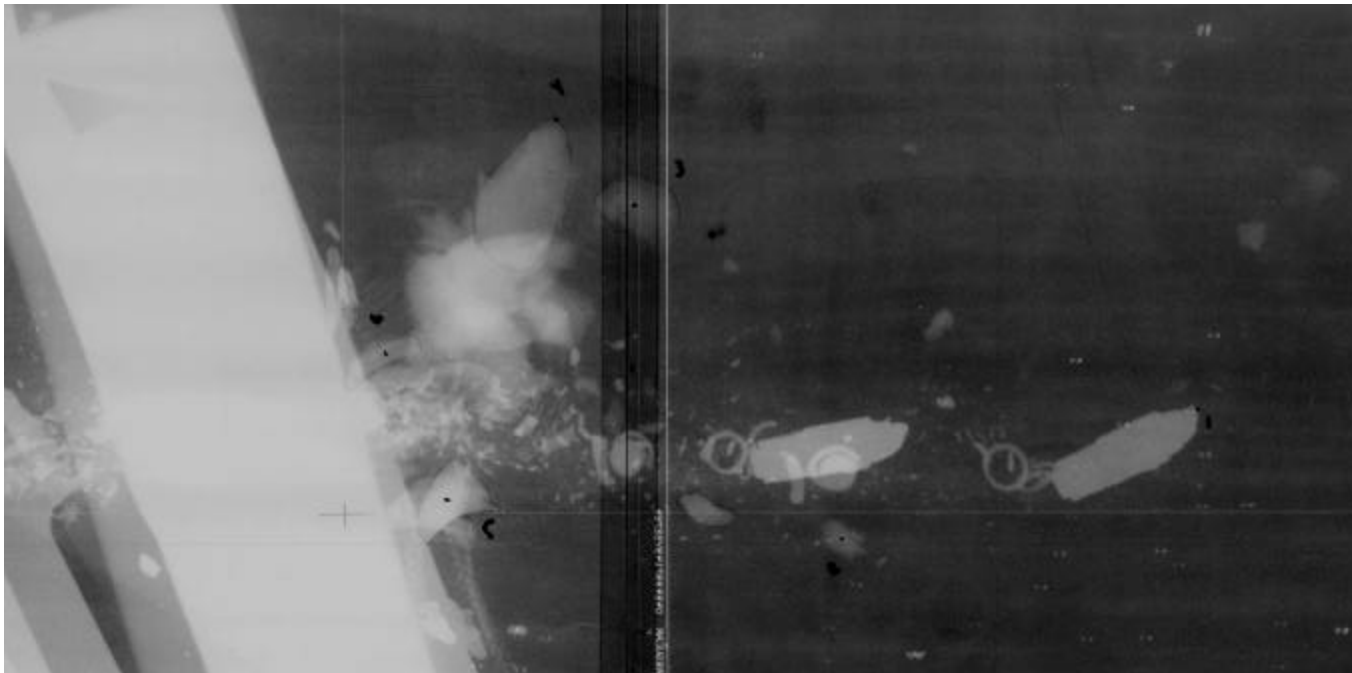
Testing Completed to Date

- Tested initial NOVEL Penetrator Designs developed by CCAC In Dec 00 & Jan 01:
 - First Attempt at making NOVEL rods in Med Cal Size (40mm)
 - Goal:
 - See if NOVEL penetrator concepts penetrate complex targets and see what is the condition of the residual core
 - Desired Performance:
 - Help W penetrators avoid fracturing
 - Add W penetrator fragments to the BAD
 - Be capable of carrying a frangible material through the armor to increase BAD

NOVEL CONCEPTS

Behind Armor Effects

40mm Caliber APFSDS Rod



BAE

*Large residual fragments adding to the BAE – higher density than aluminum
and moving at higher velocity*

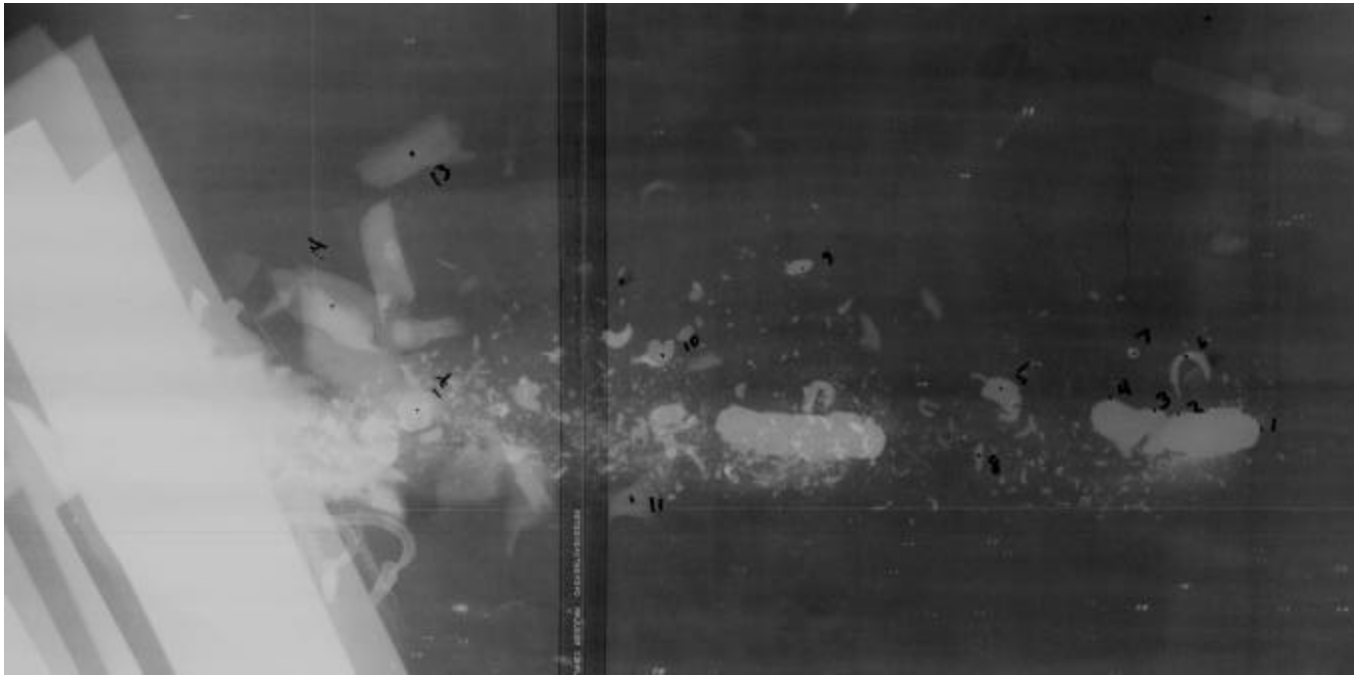
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NOVEL CONCEPTS

Behind Armor Effects

40mm Caliber APFSDS Rod



BAE *Large residual fragments adding to BAE – higher density than aluminum and moving at higher velocity. Lots of small shear fragments as well.*

Testing Conclusions

- NOVEL approach adds to the fragmenting debris
- Strong possibility a “W” frangible Material might be more successful
- Minimal degradation in V50 results
- Possible degradation in R50
 - Heavier mass at launch means lower MV with same propellant charge weights
- Still insufficient BAD to significantly increase P_k
 - Concept needs further refinement

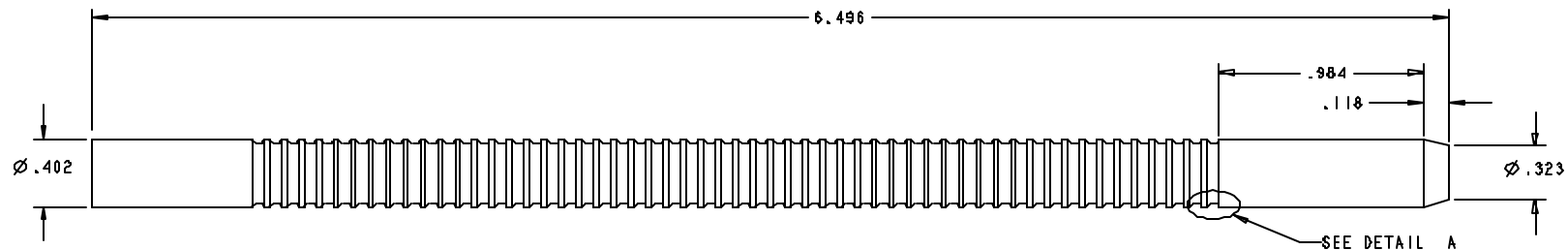
Future Advanced KE Test Plans

- CY01
 - Jul/Aug : optimize the NOVEL approach (4 concepts)
 - Oct/Nov: optimize the ENLE approach (3 concepts)
- CY02
 - May/Jun : (4 design approaches)
 - Final NOVEL design approach
 - Final ENLE design approach w/ inert insert
 - ENLE approach w/ explosive (MIC) tail insert
 - Single Crystal W or other design yet TBD
- CY03
 - May/Jun
 - Best Overall Candidate
 - Complete Cardioid Testing & SQuASH Modeling

Accomplishments to Date

- Both FY01 Advanced KE Task Order Contracts have been awarded
- Have established the following baseline concepts :
 - AP & A/B Steel Cartridge Cases
 - Baseline Monolithic AP Penetrator Core
 - Selected Baseline A/B projectile concepts
 - 40mm MANN Barrel (Breech & rifling profiles)
 - Cartridge Interface Drawings
 - Four NOVEL penetrator design approaches for Lab testing in Jul 01

Baseline Monolithic Penetrator



- Usable in the MK44 Super 40mm & CTA Weapons
- Standard “W” Material; 93% W with Ni, Fe, & Co
- Mass and Effective L/D to be maintained
- Buttress teeth design left to the discretion of GD-OTS

CY01 Programmatic Milestones

- Jun 01 - delivery of two prototype 40mm MANN barrels
- Jul/Aug 01 – testing of NOVEL core concepts at ARL
- Aug 01 - delivery of AP & A/B Cartridge Cases to GD
- Sep 01 - Initiation of A/B propellant assessments at GD (St Marks, FL)
- Oct/Nov 01- testing of ENLE core concepts at ARL
- Oct 01 - Initiation of AP propellant assessments at GD (Camden, AK)
- Nov 01 – Initial testing of full-up prototype AP round at GD (Camden, AK)

Moving On

- *Third Part of Presentation*
 - Mr. Liss – General Overview and Goals
 - Mr. Gary “Max” Fleming – Detailed Presentation of Advanced KE and Demonstrator Efforts
 - **Mr. Hirlinger – Detailed Presentation of Air Bursting Munitions Efforts**